Quantum Computing as a Subjective Reflection of Reality

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Abstract

This paper proposes a quantum computing model that interprets consciousness as a process of superposition and decoherence within an individual qubit. The evolution of the Bloch vector under decoherence is analyzed, and a quantum coherence parameter is defined to characterize the transition between different dynamic regimes.

1 Introduction

Quantum computing transcends classical bit processing by using qubits, which exploit superposition and entanglement. By modeling consciousness as an open quantum system, we examine how interaction with the environment induces decoherence and how the individual processes information in a quantum regime. This approach offers a mathematical perspective to quantify perception and its dynamic transition.

2 Quantum Mathematical Model

Let us consider a qubit interacting with a bosonic environment. The density matrix $\rho(t)$ evolves according to the Lindblad equation:

$$\frac{d\rho}{dt} = -\frac{i}{\hbar}[H, \rho] + \gamma \left(L\, \rho\, L^\dagger - \tfrac{1}{2}\{L^\dagger L, \rho\} \right). \tag{1}$$

Where

$$H = \frac{\hbar\,\Delta}{2}\,\sigma_z + \frac{\hbar\,\Omega}{2}\,\sigma_x, \quad L = \sigma_z,$$

and γ is the decoherence rate.

Defining the components of the Bloch vector:

$$x(t) = \mathrm{Tr}\,(\rho\,\sigma_x)\,, \quad y(t) = \mathrm{Tr}\,(\rho\,\sigma_y)\,,$$

we obtain the system

$$\dot{x} = -\Gamma_2\, x + \Delta\, y, \tag{2}$$
$$\dot{y} = -\Delta\, x - \Gamma_2\, y. \tag{3}$$

Equilibrium positions:

$$x = 0, \quad y = 0.$$

Jacobian at the equilibrium point:

$$J = \begin{pmatrix} -\Gamma_2 & \Delta \\ -\Delta & -\Gamma_2 \end{pmatrix}.$$

Its invariants are:

$$\operatorname{tr} J = -2\,\Gamma_2, \quad \det J = \Gamma_2^2 + \Delta^2.$$

We define the quantum coherence parameter:

$$C = \frac{\Delta}{\Gamma_2}.$$

When $C > 1$, the system exhibits damped oscillations (subcritical focus), analogous to a perceptual bifurcation toward a stable state of coherence.

3 Appendix

For illustration, let us take hypothetical values:

$$\Delta = 5\,\mathrm{MHz}, \quad \Gamma_2 = 2\,\mathrm{MHz}, \quad \Omega = 1\,\mathrm{MHz}.$$

The system becomes:

$$\dot{x} = -2\,x + 5\,y, \tag{4}$$
$$\dot{y} = -5\,x - 2\,y. \tag{5}$$

Equilibrium remains $(0, 0)$ and

$$C = \frac{5}{2} = 2.5 > 1.$$

Coherence decays exponentially with angular frequency $\omega = \Delta$ and decoherence time $T_2 = 1/\Gamma_2$.

4 References

References

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